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INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY
(Chapter II of the Patent Cooperation Treaty)

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference P7744PC00	FOR FURTHER ACTION See Form PCT/IPEA/416	
International application No. PCT/FI2004/000673	International filing date (day/month/year) 12.11.2004	Priority date (day/month/year) 17.11.2003
International Patent Classification (IPC) or national classification and IPC H04B 1/69, H04L 27/00		
Applicant Nokia Corporation et al		

1. This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36.
2. This REPORT consists of a total of 4 sheets, including this cover sheet.
3. This report is also accompanied by ANNEXES, comprising:
- a. ☒ (sent to the applicant and to the International Bureau) a total of 11 sheets, as follows:
- ☐ sheets of the description, claims and/or drawings which have been amended and are the basis of this report and/or sheets containing rectifications authorized by this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions).
- ☐ sheets which supersede earlier sheets, but which this Authority considers contain an amendment that goes beyond the disclosure in the international application as filed, as indicated in item 4 of Box No. I and the Supplemental Box.
- b. ☐ (sent to the International Bureau only) a total of (indicate type and number of electronic carrier(s)) _____, containing a sequence listing and/or tables related thereto, in electronic form only, as indicated in the Supplemental Box Relating to Sequence Listing (see Section 802 of the Administrative Instructions).

4. This report contains indications relating to the following items:

- ☒ Box No. I Basis of the report
- ☐ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☐ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☐ Box No. VII Certain defects in the international application
- ☐ Box No. VIII Certain observations on the international application

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Date of submission of the demand 23.06.2005	Date of completion of this report 07.10.2005
Name and mailing address of the IPEA/SE Patent- och registreringsverket Box 5055 S-102 42 STOCKHOLM Facsimile No. +46 8 667 72 88	Authorized officer Roger Bou Faisal/MP Telephone No. +46 8 782 25 00

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.

PCT/FI2004/000673

Box No. I Basis of the report

1. With regard to the language, this report is based on:

- ☒ the international application in the language in which it was filed
- ☐ a translation of the international application into _____,
which is the language of a translation furnished for the purposes of:
- ☐ international search (Rules 12.3(a) and 23.1(b))
- ☐ publication of the international application (Rule 12.4(a))
- ☐ international preliminary examination (Rules 55.2(a) and/or 55.3(a))

2. With regard to the elements of the international application, this report is based on (*replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report*):

- ☐ the international application as originally filed/furnished
- ☒ the description:
pages 1-3, 7-15 as originally filed/furnished
pages* 4-6, 6a received by this Authority on 23.06.2005
pages* _____ received by this Authority on _____
- ☒ the claims:
pages _____ as originally filed/furnished
pages* _____ as amended (together with any statement) under Article 19
pages* 16-22 received by this Authority on 23.06.2005
pages* _____ received by this Authority on _____
- ☒ the drawings:
pages 1-5 as originally filed/furnished
pages* _____ received by this Authority on _____
pages* _____ received by this Authority on _____
- ☐ a sequence listing and/or any related table(s) – see Supplemental Box Relating to Sequence Listing.

3. ☐ The amendments have resulted in the cancellation of:

- ☐ the description, pages _____
- ☐ the claims, Nos. _____
- ☐ the drawings, sheets/figs _____
- ☐ the sequence listing (*specify*): _____
- ☐ any table(s) related to the sequence listing (*specify*): _____

4. ☐ This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).

- ☐ the description, pages _____
- ☐ the claims, Nos. _____
- ☐ the drawings, sheets/figs _____
- ☐ the sequence listing (*specify*): _____
- ☐ any table(s) related to the sequence listing (*specify*): _____

* If item 4 applies, some or all of those sheets may be marked "superseded."

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.

PCT/FI2004/000673

Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims	<u>1-34</u>	YES
	Claims		NO
Inventive step (IS)	Claims	<u>1-34</u>	YES
	Claims		NO
Industrial applicability (IA)	Claims	<u>1-34</u>	YES
	Claims		NO

2. Citations and explanations (Rule 70.7)

The object of the invention is to provide a fully two-directional ultra-wideband (UWB) communication link.

The problem with prior art is that link control information, such as acknowledgement messages, which is needed for maintaining the communication link between the communicating parties, is sent in the same physical channel with the actual data.

Documents cited in the international search report:

D1: US 2003189975, A1

D2: US 2003194979, A1

D3: US 2003043934, A1

Document D1 is considered to represent the closest prior art. D1 relates to an impulse radio transceiver for full duplex ultra wide-band communications. The transceiver comprises an impulse radio transmitter that transmits impulse radio signal pulses, an impulse radio receiver that receives impulse radio signal pulses. Either or both of the impulse radio transmitter and the impulse radio receiver synchronizes the transmission and the reception of the impulse radio signal pulses for pulse interleaved communications. Pulse interleaving avoids self-interference between the transmitted impulse radio signal pulses and the received impulse radio signal pulses. In addition to pulse interleaved communications, bursts of pulses can be transmitted between two transceivers in an interleaved fashion. Alternatively, two different pulse repetition rates can be used to transmit and receive impulse radio signal pulses simultaneously. Still further, selected

.../...

Supplemental Box

In case the space in any of the preceding boxes is not sufficient.

Continuation of: BOX V

pulses of the received or transmitted impulse radio signal pulses are blanked to avoid interference (abstract; paragraph [0014]-[0017]; and claims 1-10).

Independent claim 1:

Amended claim 1 defines that the communicating parties negotiate whether a second set of bits is sent interlaced with a first set of bits based upon the pulse repetition frequency (PRF) used on the communication link. D1 does not disclose or suggest that the pulse interlaced would depend on the PRF of the communication link used.

Amended claim 1 is hence both novel and solves a different problem than D1 so that D1 would not have led a person skilled in the art to the claimed invention.

Independent claims 10, 11, 20, 29, 31, 33 and 34:

Based on the statement above, the invention according to amended claims 10, 11, 20, 29, 31, 33 and 34 is novel and is considered to involve an inventive step.

Accordingly, the invention defined in amended claims 1- 34 is novel and is considered to involve an inventive step. The invention is industrially applicable.

vented.

An embodiment of the invention is based on the idea of sending control information (or some other data) in uplink substantially simultaneously or interlaced with receiving data in downlink. The control information may be sent for example during guard times between received data pulses or by using a separate radio, the separate radio typically having lower data rate than the UWB radio. Typically such separate radio is a Wireless Personal Area Network (WPAN) radio, such as a Bluetooth radio or a WLAN (Wireless Local Area Network) radio. Also any other suitable radio may be used.

It must be noted that herein the terms uplink and downlink are used simply for referring to opposite directions of data transmission and therefore they can be used interchangeably.

- According to a first aspect of the invention, there is provided a communication method comprising:
- establishing a wideband communication link between a first device and a second device,
 - transmitting a first set of consecutive data bits from said first device to said second device by means of a first set of pulses,
 - transmitting a second set of bits from said second device to said first device at least partially simultaneously or at least partially interlaced with said first set of bits, characterized by:
 - negotiating a pulse repetition frequency (PRF) for said communication link, at least when PRF for the communication link is not already known, and negotiating on the basis of the PRF of said communication link, whether said second set of bits is sent interlaced with the first set of bits.
 - The pulses that are used are for example narrow pulses or impulses.

Said second set of bits may comprise any bits that need to be transmitted. Such bits may comprise for example control data, such as acknowledgement messages and reception power level information. However, depending on the implementation the second set of bits may comprise also actual uplink data, thereby providing a fully two-directional communication link.

According to a second aspect of the invention, there is provided a system comprising
a first device and a second device configured to establish a wideband communication link between said first and second devices, said first device comprising a transmitter configured to send a first set of consecutive data bits to said second device and said second device comprising a receiver configured to receive said first set of consecutive data bits from said first device, said first set of bits being sent by means of a first set of pulses, wherein
said second device further comprises a transmitter configured to send a second set of bits to said first device at least partially simultaneously or at least partially interlaced with receiving said first set of bits from said first device, and

said first device further comprises a receiver configured to receive said second set of bits from said second device at least partially simultaneously or at least partially interlaced with sending said first set of bits to said second communication device, **characterized** in that the first device and the second device are further configured:

to negotiate a pulse repetition frequency (PRF) for said communication link, at least when PRF for the communication link is not already known, and
to negotiate on the basis of the PRF of said communication link, whether said second set of bits is sent interlaced with the first set of bits.

According to a third aspect of the invention, there is provided a device comprising a receiver configured to receive a first set of consecutive data bits from another device, said first set of bits being sent by means a first set of pulses, and
a transmitter configured to send a second set of bits to said another device at least

partially simultaneously or at least partially interlaced with receiving said first set of bits from said another device, characterized by

means for negotiating a pulse repetition frequency (PRF) for said communication link, at least when PRF for the communication link is not already known, and

- 5 means for negotiating on the basis of the PRF of said communication link, whether said second set of bits is sent interlaced with the first set of bits..

According to a fourth aspect of the invention, there is provided a device comprising

- 10 a transmitter configured to send a first set of consecutive data bits to another device by means of a first set of pulses, and

a receiver configured to receive a second set of bits from said another device at least partially simultaneously or at least partially interlaced with sending said first set of bits to said another device, characterized by:

- 15 means for negotiating a pulse repetition frequency (PRF) for said communication link, at least when PRF for the communication link is not already known, and
means for negotiating on the basis of the PRF of said communication link, whether said second set of bits is sent interlaced with the first set of bits.

- 20 A device according to the invention may be any suitable electronic device such as a communication device, a mobile phone, a laptop computer, a desktop computer, a Personal Digital Assistant (PDA), or a digital camera. The features of the devices according to the third and fourth aspects may be combined so that some of the features or all of them are implemented in one device.

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According to a fifth aspect of the invention, there is provided a computer program according to claim 29.

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According to a sixth aspect of the invention, there is provided a computer program according to claim 31.

- 5 According to a seventh aspect of the invention, there is provided a communication module according to claim 33.

According to a eighth aspect of the invention, there is provided a communication module according to claim 34.

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Dependent claims contain some embodiments of the invention. The subject matter contained in dependent claims relating to a particular aspect of the invention is also applicable to other aspects of the invention.

- 15 A benefit of some embodiments of the invention is that they improve UWB communication data rate by providing a method for sending uplink information without reducing downlink data rate. However, it must be noted that in addition to UWB communication technology, the invention can be used in connection with any other suitable communication technology employing narrow or short duration
- 20 pulses or impulses in data transmission purposes.

2 3 -06- 2005

CLAIMS:

1. A communication method comprising:
 - establishing (15) a wideband communication link between a first device
 - 5 (11, 50, 60) and a second device (12, 51, 61),
 - transmitting (16) a first set of consecutive data bits from said first device to said second device by means of a first set of pulses,
 - transmitting (17) a second set of bits from said second device to said first device at least partially simultaneously or at least partially interlaced with said
 - 10 first set of bits, **characterized by:**
 - negotiating a pulse repetition frequency (PRF) for said communication link, at least when PRF for the communication link is not already known, and
 - negotiating on the basis of the PRF of said communication link, whether said second set of bits is sent interlaced with the first set of bits.
 - 15
2. The method of claim 1, wherein said pulses are narrow pulses.
3. The method of claim 1 or 2, wherein said pulses are spaced apart in time domain by a certain guard time and said second set of bits is transmitted by
- 20 means of a second set of pulses sent during said guard times.
4. The method of claim 3 further comprising:
 - negotiating on the basis of the PRF of said communication link, whether said guard times are used for sending said second set of bits.
 - 25
5. The method of claim 1 or 2, wherein a separate radio is used for transmitting said second set of bits.
6. The method of claim 5, wherein said separate radio is a Wireless Personal
- 30 Area Network (WPAN) radio.

7. The method of claim 5 or 6, wherein said second set of bits is transmitted as payload in a data channel of the separate radio.
8. The method of any one of the preceding claims, wherein said second set of bits comprises control data.
9. The method of any one of the preceding claims, wherein said wideband communication link is an ultra-wideband (UWB) communication link.
10. A system comprising
- a first device (11, 50, 60) and a second device (12, 51, 61) configured to establish a wideband communication link between said first and second devices, said first device comprising a transmitter configured to send a first set of consecutive data bits to said second device and said second device comprising a receiver configured to receive said first set of consecutive data bits from said first device, said first set of bits being sent by means of a first set of pulses,
- said second device (12, 51, 61) further comprises a transmitter (42) configured to send a second set of bits to said first device at least partially simultaneously or at least partially interlaced with receiving said first set of bits from said first device, and
- said first device (11, 50, 60) further comprises a receiver (46) configured to receive said second set of bits from said second device at least partially simultaneously or at least partially interlaced with sending said first set of bits to said second communication device, **characterized** in that the first device (11, 50, 60) and the second device (11, 50, 60) are further configured:
- to negotiate a pulse repetition frequency (PRF) for said communication link, at least when PRF for the communication link is not already known, and
- to negotiate on the basis of the PRF of said communication link, whether said second set of bits is sent interlaced with the first set of bits.

11. A device (12, 51, 61) comprising
- a receiver (46) configured to receive a first set of consecutive data bits from another device, said first set of bits being sent by means a first set of pulses and
- 5 a transmitter (42) configured to send a second set of bits to said another device at least partially simultaneously or at least partially interlaced with receiving said first set of bits from said another device, **characterized** in that said device further comprises:
- means for negotiating a pulse repetition frequency (PRF) for said communication link, at least when PRF for the communication link is not already known, and
- 10 means for negotiating on the basis of the PRF of said communication link, whether said second set of bits is sent interlaced with the first set of bits.
12. The device of claim 11, wherein said pulses are narrow pulses.
13. The device of claim 11 or 12, wherein
- said receiver is configured to receive said first set of pulses so that there is a certain guard time between the pulses, and
- 20 said transmitter is configured to send a second set of pulses forming said second set of bits during said guard times.
14. The device of claim 13 further comprising:
- means for negotiating with said another device pulse repetition frequency (PRF) for said first set of pulses, at least when said PRF is not already known, and
- 25 means for negotiating on the basis of said PRF, whether said guard times are used for sending said second set of bits.
15. The device of claim 11 or 12, wherein said transmitter and said receiver employ different radio technologies.
- 30

16. The device of claim 15, wherein said transmitter is a Wireless Personal Area Network (WPAN) radio transmitter.
- 5 17. The device of any one of claims 11-16, wherein said receiver is an ultra-wideband (UWB) receiver.
18. The device of any one of claims 11-17, wherein said second set of bits comprises control data.
- 10 19. The device of any one of claims 11-18, wherein said device is one of the following: a communication device, a mobile phone, a laptop computer, a desktop computer, a Personal Digital Assistant (PDA), and a digital camera.
- 15 20. A device (11, 50, 60) comprising
a transmitter (42) configured to send a first set of consecutive data bits to another device by means of a first set of pulses, and
a receiver (46) configured to receive a second set of bits from said another device at least partially simultaneously or at least partially interlaced
20 with sending said first set of bits to said another device, **characterized** in that said device further comprises:
means for negotiating a pulse repetition frequency (PRF) for said communication link, at least when PRF for the communication link is not already known, and
25 means for negotiating on the basis of the PRF of said communication link, whether said second set of bits is sent interlaced with the first set of bits.
21. The device of claim 20, wherein said pulses are narrow pulses.
- 30 22. The device of claim 20 or 21, wherein
said transmitter is configured to send said first set of pulses so that there

is a certain guard time between the pulses, and

said receiver is configured to receive a second set of pulses forming said second set of bits during said guard times.

5 23. The device of claim 22 further comprising:

means for negotiating with said another device pulse repetition frequency (PRF) for said first set of pulses, at least when said PRF is not already known, and

10 means for negotiating on the basis of said PRF, whether said guard times are used for receiving said second set of bits.

24. The device of claim 20 or 21, wherein said transmitter and said receiver employ different radio technologies.

15 25. The device of claim 24, wherein said receiver is a Wireless Personal Area Network (WPAN) radio receiver.

26. The device of any one of claims 20-25, wherein said transmitter is an ultra-wideband (UWB) transmitter.

20

27. The device of any one of claims 20-26, wherein said second set of bits comprises control data.

25 28. The device of any one of claims 20-27, wherein said device is one of the following: a communication device, a mobile phone, a laptop computer, a desktop computer, a Personal Digital Assistant (PDA), and a digital camera.

29. A computer program executable in a communication device, the communication device being configured to receive a first set of consecutive data bits from another device, said first set of bits being sent by means of pulses, said computer program controlling said communication device to

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send a second set of bits to said another device at least partially simultaneously or at least partially interlaced with receiving said first set of bits from said another device, **characterized** by said computer program further controlling said communication device

- 5 to negotiate a pulse repetition frequency (PRF) for said communication link, at least when PRF for the communication link is not already known, and
to negotiate on the basis of the PRF of said communication link, whether said second set of bits is sent interlaced with the first set of bits.

10 30. The computer program of claim 29 stored on a carrier.

31. A computer program executable in a communication device, the communication device being configured to send a first set of consecutive data bits to another device by means of pulses, said computer program controlling
15 said communication device to

receive a second set of bits from said another device at least partially simultaneously or at least partially interlaced with sending said first set of bits to said another device, **characterized** by said computer program further controlling said communication device:

- 20 to negotiate a pulse repetition frequency (PRF) for said communication link, at least when PRF for the communication link is not already known, and
to negotiate on the basis of the PRF of said communication link, whether said second set of bits is sent interlaced with the first set of bits.

25 32. The computer program of claim 31 stored on a carrier.

33. A communication module (40) comprising

- a receiver (46) configured to receive a first set of consecutive data bits from another device, said first set of bits being sent by means a first set of
30 pulses and

a transmitter (42) configured to send a second set of bits to said another

device at least partially simultaneously or at least partially interlaced with receiving said first set of bits from said another device, **characterized** by said communication module further comprising:

5 means for negotiating a pulse repetition frequency (PRF) for said communication link, at least when PRF for the communication link is not already known, and

means for negotiating on the basis of the PRF of said communication link, whether said second set of bits is sent interlaced with the first set of bits.

10 34. A communication module (40) comprising

a transmitter (42) configured to send a first set of consecutive data bits to another device by means of a first set of pulses, and

15 a receiver (46) configured to receive a second set of bits from said another device at least partially simultaneously or at least partially interlaced with sending said first set of bits to said another device, **characterized** by said communication module further comprising:

means for negotiating a pulse repetition frequency (PRF) for said communication link, at least when PRF for the communication link is not already known, and

20 means for negotiating on the basis of the PRF of said communication link, whether said second set of bits is sent interlaced with the first set of bits.

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